FSIS Compliance Guideline for Validating Cooking Instructions for Mechanically Tenderized Beef Products

2015

This guidance document is designed to help establishments that manufacture mechanically tenderized beef products to comply with the requirements in 9 CFR 317.2(e)(3)(iii) by:

- Identifying the minimum components of validated cooking instructions;
- Identifying the two elements to validating cooking instructions:
    - Scientific and technical support (design) and
    - In-plant validation data (execution)

To help establishments meet the first element of validation, this document contains attachments establishments can use as scientific support for cooking instructions.

Preface

What is the purpose of this Compliance Guideline?

The purpose of this guideline is to help establishments ensure that their labels on raw or partially cooked needle- or blade-tenderized beef products destined for household consumers, hotels, restaurants, or similar institutions contain validated cooking instructions that comply with the requirements in 9 CFR 317.2(e)(3)(iii). Note that these requirements are not in effect until May 17, 2016. In addition, FSIS will delay enforcing the labeling requirements for beef products with added solutions until the same date.

Specifically, the guideline articulates:

- The minimum components validated cooking instructions must contain;
- The two elements to validating cooking instructions:
    - Scientific and technical support (design) and
    - In-plant validation data (execution)

This document contains attachments that establishments can use as scientific support to meet the first element of validation.

This document provides **guidance** to assist establishments in meeting FSIS regulations. Guidance represents **best practice** recommendations by FSIS based on the best scientific and practical considerations. It does not represent **requirements** that must be met. Establishments may choose to adopt different procedures than those outlined in this Guideline, but they would need to support why those procedures are effective. It is important to note that this Guideline represents FSIS's current thinking on this topic.

Who is this Compliance Guideline designed for?

This guideline is designed for all official FSIS regulated establishments that produce raw or partially cooked mechanically tenderized beef products destined for household consumers, hotels, restaurants, or similar institutions. Such products include raw or partially cooked needle or blade tenderized beef products, including mechanically tenderized beef products that have also been injected with marinade or solution. This guideline is not intended for establishments that produce mechanically tenderized product that will be fully cooked at an official establishment.

Is this version of the guideline final?

Yes, this version of the guideline, dated May, 2015 is final and replaces the previous version dated June, 2013. Guidelines will be continually updated to reflect the most current information available to FSIS and stakeholders, although comments will no longer be accepted through regulations.gov on this guideline.

What changes have been made to the guideline since the last version?

The following changes have been made to the June, 2013 version of the guideline in response to public comments:

- Based on findings from recent research shared in the comments, a **recommendation** to include the following statements as part of the validated cooking instructions was added:
  - "Fully thaw product before cooking," and
  - For mechanically tenderized steaks, "Turn product over at least twice during cooking".
- Clarified that not all of the time and temperature combinations *FSIS Guidance on Safe Cooking of Non-Intact Meat Chops, Roasts, and Steaks* are practical for consumers to follow. Specifically, the rest times associated with the temperatures less than 145°F (e.g., 144°F for 4 minutes, 143°F for 5 minutes, etc.) are not practical for consumers to maintain.
- Portion size was addressed as a factor to consider when designing a validation study.
- Based on findings from recent research shared in the comments, additional scientific support for cooking instructions was included in Attachment 1.

In addition, outbreak data was revised to reflect outbreaks from mechanically tenderized beef products that occurred since 2000. This change was made to be consistent with the data reported in the Federal Register Notice.

What if I still have questions after I read this guideline?

If the desired information cannot be found within the Compliance Guideline, FSIS recommends that users search the publicly posted Questions & Answers (Q&As) in the AskFSIS database or submit questions through AskFSIS. Documenting these questions helps FSIS improve and refine present and future versions of the Compliance Guideline and associated issuances. When submitting a question, use the Submit a Question tab, and enter the following information in the fields provided:

Subject Field: Enter **FSIS Compliance Guideline for Validating Cooking Instructions for Mechanically Tenderized Beef Products**
Question Field: Enter question with as much detail as possible.
Product Field: Select **General Inspection Policy** from the drop-down menu.
Category Field: Select **Sampling** from the drop-down menu.
Policy Arena: Select **Domestic (U.S.) Only** from the drop-down menu.

When all fields are complete, press **Continue**.

FSIS Compliance Guideline for Validating Cooking Instructions for Mechanically Tenderized Beef Products

Table of Contents

FSIS Compliance Guideline for Validating Cooking Instructions for Mechanically Tenderized Beef Products

Why must mechanically tenderized beef products be labeled with validated cooking instructions?

Effective May 17, 2016, 9 CFR 317.2(e)(3)(iii) requires that the labels on raw or partially cooked needle- or blade-tenderized beef products destined for household consumers, hotels, restaurants, or similar institutions contain validated cooking instructions. FSIS added this requirement because scientific evidence shows that mechanically tenderized beef products need to be fully cooked in order to sufficiently reduce the risk pathogenic bacteria. Pathogenic bacteria may be present on the interior of mechanically tenderized beef products because any contamination on the outside of the product may be carried to the inside through penetration by needles and other devices. As a result, it is important that mechanically tenderized beef products be cooked thoroughly as opposed to "rare" or "medium rare".

Consumers often request that restaurants cook steaks "rare" or "medium-rare". Generally, intact cuts of muscle such as steaks are rendered free of pathogenic bacteria if cooked "rare" or "medium rare" provided the steaks are seared according to the recommendations in the Food Code. According to the 2009 Food Code §3-401.11(C)(3), a raw or undercooked whole-muscle, intact beef steak may be served or offered for sale in a ready-to-eat form if among other things, *"*the steak is cooked on both the top and bottom to a surface temperature of 63^{o}C (145^{o}F) or above and a cooked color change is achieved on all external surfaces.*"* Seared intact steaks may be considered a ready-to-eat food without being fully cooked because contamination with pathogenic bacteria such as *Escherichia coli* O157:H7 (*E. coli* O157:H7) and other STEC organisms, if present, would only occur on the surface of the product. As long as the external surfaces are exposed to lethality temperatures, the product can be rendered safe without thoroughly cooking the product through the interior (NACMCF, 1997).

Despite the safe handling instructions on mechanically tenderized beef products to "cook thoroughly," recent outbreak data indicate that for needle or blade tenderized raw beef products, consumers, restaurants, and retail stores do not always thoroughly cook these products to a temperature and time combination sufficient to destroy harmful bacteria, such as *E. coli* O157:H7. Indeed, in many cases, patients associated with outbreaks reported preparing or ordering steaks as "rare" or "medium-rare." Since 2000, the Centers for Disease Control and Prevention has received reports of six outbreaks attributable to needle or blade tenderized beef products prepared in restaurants and consumers' homes. Among these outbreaks, there were a total of 176 *E. coli* O157:H7 cases that resulted in 32 hospitalizations and 4 cases of hemolytic uremic syndrome (HUS). Failure to thoroughly cook a mechanically tenderized raw or

partially cooked beef product was a significant contributing factor in all of these outbreaks (Culpepper et al., 2009; Swanson et al., 2005).

Cooking instructions for these products should inform consumers that these products need to be cooked to a specified minimum internal temperature, and should identify whether they need to be held at that minimum temperature for a specified time before consumption, i.e., rest or dwell time, so that that they are thoroughly cooked. This document provides guidance on how to validate such cooking instructions.

What are the minimum components of validated cooking instructions that must be on the label to comply with the requirements in 9 CFR 317.2(e)(3)(iii)?

The cooking instructions must include, at a minimum:

(1) The method of cooking;

(2) A validated minimum internal temperature that would destroy pathogens throughout the product;

(3) A statement as to whether the product cooked in the manner described also needs to be held for a specific time at the specified temperature or higher before consumption; and

(4) Instruction that the internal temperature should be measured by the use of a thermometer.

The cooking instructions included on the label should be practical and easily followed by consumers.

To the right is an example of cooking instructions that meet these minimum components. Note that these instructions are in addition to the Safe Handling instructions required on raw beef products in 9 CFR 317.2(l)(1).

For Food Safety and Quality Follow These Cooking Instructions:
Gas Grill:
1) Heat gas grill on Medium-High.
2) Cook for 6 minutes to an internal temperature of 145°F as measured with a food thermometer. Flip steak over at least twice during cooking.
3) After removing from the gas grill, allow meat to rest for at least three minutes before serving.

In this example, to meet requirements, an establishment would need to validate that the cooking instructions will achieve the time and temperature combination on the label (i.e., 145°F for 3 minutes). Once it validates the cooking instructions, the establishment would not need any additional scientific support to meet the first element of validation. No additional documentation would be needed because the *FSIS Guidance on Safe Cooking of Non-Intact Meat Chops, Roasts, and Steaks* supports that adequate reduction of

pathogens would be achieved with a desired endpoint temperature of 145°F and a rest time of 3 minutes.

Are there additional instructions FSIS recommends establishments include on the label?

FSIS reviewed the literature and found that achieving a consistent temperature throughout beef products is key to ensuring adequate lethality of pathogenic bacteria is achieved (Gill et al., 2013). Two factors identified in the literature that can affect even heating include the state of the product before cooking (e.g., frozen, refrigerated, or room temperature) and the amount of times during cooking steaks are turned over (i.e., flipped) (Berry, 2000; Gill et all, 2013; Luchansky, 2014). Based on these findings, FSIS recommends establishments include the following two additional instructions on the label of mechanically tenderized beef products in order to ensure that consumers achieve a consistent temperature throughout the product needed to sufficiently reduce the presence of potential pathogens:

1. *"Fully thaw before cooking"*

FSIS recommends establishments include the instruction "fully thaw before cooking" on the labels of mechanically tenderized beef products to achieve even heating in the product. Research with patties has shown that temperatures tend to be more consistent across patties that are cooked from the thawed rather than the frozen state (Berry, 2000). Not surprisingly, other research has found that patties cooked from the frozen state take longer to achieve the target endpoint temperature than those that have been thawed (Luchansky, 2013). Even if this instruction is provided, establishments should consider conducting additional tests to assess the impact on cooking adequacy if the consumer does not fully thaw the product prior to cooking. Alternatively, two sets of validated cooking instructions could be provided: one for preparation of thawed product and one for preparation of frozen product. These practices are recommended in GMA's 2008 *Guidelines for Validation of Consumer Cooking Instructions for Not-Ready-to-Eat (NRTE) Products* and discussed further on page 10 of this guideline because consumers may ignore warnings and cook the product from the frozen state. When asked, consumers report cooking beef patties from the frozen state without thawing approximately 22% of the time (Phang and Bruhn, 2011). Including this instruction on the label may have additional benefits for quality as thawing frozen patties before cooking has also been found to improve sensory properties such as juiciness (Bigner-George and Berry, 2000).

2. For mechanically tenderized steaks, "Turn steak over at least twice during cooking"

For mechanically tenderized steaks, FSIS recommends establishments also include the instruction to "turn steak over at least twice during cooking" so that consumers consistently achieve the desired endpoint temperature throughout the steak. This recommendation is based on research that shows turning steaks over at least twice results in more even heating and, as a result, more consistent reductions in *E. coli*

O157:H7 than turning steaks over once (Gill et al., 2013). The recommendation to "turn over" mechanically tenderized steaks does not apply to other mechanically tenderized beef products such as roasts since larger cuts of mechanically tenderized beef will typically experience longer come up times contributing to additional lethality in the product over the entire cooking time. In addition, roasts and other large cuts are often cooked by consumers in moist environments that contain humidity contributing to even cooking (e.g., in cooking large cuts of meat in slow cookers with the lid in place and roasting large cuts of meat such as roasts by adding water or broth to the pan and tenting foil over the product). Consistent with this recommendation, the Food and Drug Regulations in Canada require the statement "turn steak over at least twice during cooking" on the principal display panel of mechanically tenderized steaks to achieve a consistent temperature throughout these products (Health Canada, 2014).

NOTE: The final rule does not require establishments to include the instructions "fully thaw before cooking" and "turn steak over at least twice during cooking" on the label of mechanically tenderized beef products. These instructions are included in this guideline as recommendations. FSIS is recommending these additional instructions be included on the label of mechanically tenderized beef products because thawing steaks before cooking and flipping steaks over at least twice during cooking has been found to help ensure that consumers achieve a consistent temperature throughout the product. Achieving a consistent temperature throughout the product is critical to ensuring that potential pathogens in the interior of the product are sufficiently reduced. FSIS did not propose to include these instructions in the proposed rule (78 FR 34589) and is therefore, not requiring these instructions be included in the final rule.

How can an establishment validate its cooking instructions?

There are two main elements to validation which also apply to the process of validating cooking instructions.

ELEMENT 1: Scientific or Technical Support (Design)

The first part to validating cooking instructions is providing scientific or technical support for the judgments made in designing the cooking instructions. The scientific support should demonstrate that:

- The cooking instructions provided can repeatedly achieve the desired minimum internal temperature and, if applicable, rest time and
- The minimum internal temperature and time at that temperature achieved by the instructions will destroy pathogens present in the product.

To collect the first type of support, demonstrating that the cooking instructions can repeatedly achieve the desired minimum internal temperature and, if applicable, the rest time, the cooking instructions are generally repeatedly followed under actual consumer

cooking conditions to show that the desired endpoint temperature and rest time can consistently be met. For example, if an establishment has instructions which state to cook a mechanically tenderized steak on a grill for 7 minutes in order to heat the steak to 160°F, then, put simply, the establishment would need to heat the steak on different types of grills several times to support that it actually takes 7 minutes to heat the steak to 160°F under different consumer cooking conditions. As a result, **this first type of scientific support does not need to consist of microbiological data but rather should include data demonstrating the cooking instructions consistently achieve the desired endpoint temperature under worst-case scenario conditions**.

It is the responsibility of the establishment to identify scientific support that demonstrates that consumers can achieve the endpoint temperature and rest time by following the cooking instructions. This type of documentation generally consists of a scientific article from a peer-reviewed journal, a published processing guideline, or data gathered in-plant or in a test kitchen. Data can be gathered anywhere the consumer cooking equipment is available.

A number of journal articles have been published in which researchers have already validated cooking instructions for mechanically tenderized beef products. To assist establishments with developing cooking instructions, Attachment 1 of this guideline contains a summary of published scientific support for cooking instructions that have been found to achieve a sufficient endpoint temperature and rest time, along with the critical operational parameters included in each study. Establishments may utilize these cooking instructions on the labels of their products provided that the actual product being produced and labeled is similar to the product for which the instructions were developed. For example, if an establishment produced a 1 inch thick blade tenderized steak, the following instructions could be used as they have been validated according to the research conducted by Gill et al. (2013) provided in Attachment 1:

For Food Safety and Quality Follow These Cooking Instructions:

1) Heat stainless steel skillet on electric stove to medium.

2) Add steak to skillet and cook for 26 minutes. Turn product over at least twice during cooking.

3) Cook until steak reaches an internal temperature of 145°F as measured by a food thermometer and allow to rest for 3 minutes before serving.***

In the research articles provided in Attachment 1, the authors determined the amount of time it would take using different cooking methods to reach different desired endpoint temperatures for steaks of different thicknesses. Only products that reached endpoint temperatures sufficient to produce a ready-to-eat product (that is one in which at least a 5-$\log_{10}$ reduction of *Salmonella* and STEC organisms such as *E. coli* O157:H7 is achieved) are included in Attachment 1.

Establishments using cooking instructions from Attachment 1 would not need to provide the original journal articles used to develop the instructions because all of the critical operational parameters have been provided in the Attachment. Therefore, if establishments utilize instructions from Attachment 1, no further scientific support is needed to meet the first element of validation.

NOTE: Establishments should be aware that the cooking instructions developed from research by Luchansky et al., 2012 and provided on pages 17 and 18 of Attachment 1 are associated with a lower margin of safety because they instruct consumers to flip the product once part way through cooking. Newer research by Gill et al., 2013, shows turning steaks over at least twice results in more even heating and, as a result, more consistent reductions in *E. coli* O157:H7 than turning steaks over once. Cooking instructions developed from this newer research are provided on pages 19 through 21 and have been found to be associated with a greater margin of safety.

KEY QUESTION

Question: If I use Attachment 1 as the scientific support for my cooking instructions, do I need additional scientific support to meet the first element of validation?

Answer: No, Attachment 1 has been developed using published research. All critical operational parameters an establishment would be expected to meet are included in the Attachment. Therefore, the establishment does not need to maintain on file the original journal articles from which the instructions were developed. In addition, only cooking instructions that achieve the minimum internal temperature and, if applicable, rest time needed to destroy potential pathogens were selected. Therefore, the establishment also does not need to maintain additional scientific support for the internal temperature and, if applicable, rest time chosen.

The list of references provided in Attachment 1 is not exhaustive. Establishments may identify other articles published in peer-reviewed journals or other scientific support that can be used to support that cooking instructions have been validated. When selecting scientific support for cooking instructions, **it is important that an establishment identify scientific support that closely matches its actual process**. In order to determine that the scientific support closely matches the actual process and the cooking instructions on the label, establishments should ensure that the documentation was developed for a product

that is similar in terms of the:

- Cut of beef,
- Method of tenderization
- Thickness
- Cooking method and
- Desired endpoint temperature and rest time (if applicable)

that will be referenced in the cooking instructions on the label.

It is important for establishments to ensure that the actual product being labeled is similar to the product studied because differences in the cut of beef, method of tenderization, thickness, and cooking method all have an impact on heat transfer and as a result, the amount of time it takes to reach the desired endpoint temperature. Therefore, if any of these parameters in the actual product or process differ from those used in the scientific support, the establishments should provide documentation as part of their validation records supporting why the desired endpoint temperature will still be reached. Such a justification could include reference to previously conducted research or scientific principles that would support that the desired endpoint temperature will still be reached. This justification is needed because the establishment cannot be sure that the desired endpoint temperature will be met if different critical operational parameters are used. If a justification cannot be provided, then additional support may be needed. For example, if an establishment produces a 2-inch thick steak, and the only available cooking instructions that have been validated are for a 1 inch steak, then the cooking instructions should not be used because it will take significantly longer to reach the desired endpoint temperature with a thicker steak (Gill, et al., 2013, Luchansky et al., 2012). The next section discusses how an establishment can validate their own cooking instructions if none are available in the literature for a similar product.

In addition to identifying scientific or technical support demonstrating that the cooking instructions can repeatedly achieve the desired endpoint temperature, an establishment should also identify scientific support that demonstrates the expected level of bacterial pathogen reduction achieved when the desired endpoint temperature is reached. Such scientific support should demonstrate that the minimum internal temperature and, if applicable, rest time in the instructions (for example 160°F instantaneously) have been validated to destroy pathogens throughout the product. This means that if the product reaches the desired minimum internal temperature for the applicable rest time, at least a 5-$\log_{10}$ reduction of *Salmonella* and STEC organisms such as *E. coli* O157:H7 will be achieved. **As a result, the scientific support for the endpoint temperature and rest time should consist of or be developed from microbiological data demonstrating an adequate reduction in pathogens is achieved.**

> **NOTE:** The cooking instructions provided in Attachment 1 of this guideline were developed to reach minimum internal temperature and rest time combinations found to achieve at least a 5-$\log_{10}$ reduction of *Salmonella* and STEC organisms such as *E. coli* O157:H7. Therefore, these instructions were developed from

microbiological data that demonstrate an adequate reduction in pathogens is achieved, and no further scientific support is needed.

It is also the responsibility of the establishment to identify scientific support for the endpoint temperature and, if applicable, rest time used for a product's cooking instructions. This type of documentation generally consists of a scientific article from a peer-reviewed journal, a published processing guideline, a challenge or inoculated pack study, or a regulatory performance standard. It is important to consider that not all cooking instructions have been developed to achieve a sufficient endpoint temperature, and if applicable, rest time. Often cooking instructions are developed to achieve a desired doneness of a product (i.e., "medium", "medium-well", or "well-done"). Cooking instructions for mechanically tenderized beef products should be developed to achieve desired endpoint temperatures in order to make a safe product.

According to the *FSIS Guidance on Safe Cooking of Non-Intact Meat Chops, Roasts, and Steaks* from April 2009 (See Attachment 2 of this guideline), products cooked to 150°F should be held or allowed to rest for at least 52 seconds to achieve at least a 5-$\log_{10}$ reduction of *Salmonella* and *E. coli* O157:H7. Products cooked above 160°F achieve a 5-$\log_{10}$ reduction in these pathogens instantaneously without any additional rest time. **The *FSIS Guidance on Safe Cooking of Non-Intact Meat Chops, Roasts, and Steaks* also supports that adequate reduction of pathogens would be achieved with a desired endpoint temperature of 145°F and a rest time of 3 minutes. If establishments can validate that their cooking instructions will achieve that time and temperature combination, they would meet requirements, and no additional scientific support would be needed to meet the first element of validation.**

Establishments may utilize the *FSIS Guidance on Safe Cooking of Non-Intact Meat Chops, Roasts, and Steaks* provided in Attachment 2 of this guideline as support for the endpoint temperature and rest time, or they may provide their own scientific support for other time and temperature combinations. If establishments use other time and temperature combinations, they must demonstrate that those other combinations achieve the same results (i.e., a 5-$\log_{10}$ reduction of *Salmonella*) as the time and temperature combinations in the table. This is because the time and temperature combinations in the FSIS Guidance were developed from microbiological data demonstrating an adequate reduction in pathogens is achieved. Although the FSIS Guidance was developed using microbiological data for *Salmonella*, the guidance can be used to support that an adequate reduction of STEC such as *E. coli* O157:H7is also achieved because *Salmonella* is considered an indicator for lethality. *Salmonella* is used as an indicator for lethality because it is more heat resistant than other pathogens such as *E. coli* O157:H7. Therefore, if a 5-$\log_{10}$ reduction of *Salmonella* is achieved, at least a 5-$\log_{10}$ reduction of *E. coli* O157:H7 should be achieved as well (Goodfellow and Grown, 1978; Line et al., 1991). In addition to the FSIS guidance, establishments may also utilize the endpoint time and temperature combinations provided in the 2013 FDA Food Code for mechanically tenderized meats in § 3-401.11(A)(2). As with the FSIS guidance, although the Food Code does not contain actual microbiological data, the

time and temperature combinations were developed from microbiological data demonstrating an adequate reduction in pathogens is achieved.

> **NOTE:** The time and temperature combinations in the *FSIS Guidance on Safe Cooking of Non-Intact Meat Chops, Roasts, and Steaks* provided in Attachment 2 of this guideline were originally developed for FSIS regulated establishments that have a high degree of process control. Although establishments may utilize the guideline as support for the endpoint temperature and rest time of consumer cooking instructions, FSIS has determined that not all of the time and temperature combinations are practical for consumers to follow. Specifically, the rest times associated with the temperatures less than 145°F (e.g., 144°F for 4 minutes, 143°F for 5 minutes, etc.) are not practical for consumers to maintain. Therefore, FSIS does not recommend an establishment design cooking instructions to achieve these time and temperature combinations unless it can document in its hazard analysis or decision-making documents contractual controls in place (e.g., agreements with Hotel, Restaurants, or Institutions) to ensure instructions are followed by the end user and why the establishment has concluded that these instructions will be effective.

How can an establishment develop its own scientific support for its cooking instructions if a product doesn't match one of those in Attachment 1 of this guideline?

If an establishment produces a product for which scientific support for cooking instructions is not readily available (for example, the product is of a different thickness or cut than one that has been studied or is partially cooked at the establishment), or if an establishment wants to provide cooking instructions for a cooking method that has not been studied, then additional scientific support will be needed. Such scientific support may be developed by collecting data in a test kitchen or other location where the cooking method (e.g., gas grill, broiler, stove top) is available for testing. Data may be collected by establishment employees or a third party, or an establishment may elect to conduct and to document a trial with consumers to monitor how well they are able to follow labeled cooking instructions.

To develop scientific support for cooking instructions, the establishment should determine the temperature of the product after it is cooked following the instructions on the label. If instructions have not already been developed, the establishment can collect data during cooking to determine the length of time it takes to reach the desired endpoint temperature. As previously discussed, the endpoint temperature and if applicable, rest time should be selected to support at least a 5-$\log_{10}$ reduction of *Salmonella* and STEC organisms such as *E. coli* O157:H7. The appropriate validation study should at least consider conditions likely to result in the lowest endpoint temperature or a worst-case scenario (NACMCF, 2006). In order to ensure the validation study represents the worst-case scenario, the following product and testing variables should be considered.

Product variables

- **Method of tenderization:** The method of tenderization - either needle/blade tenderized or injected - appears to affect the amount of cooking time needed to reach a desired endpoint temperature (Luchansky, et al 2011). Therefore, the product studied should be prepared using the same method of tenderization (ideally under actual in-plant conditions) as the product for which the cooking instructions are being developed.

- **Thickness of the product:** The thickness of the product is a critical factor for heat transfer. The thicker a product, the longer it will take for the core of the product to reach the desired endpoint temperature. Therefore, it is recommended that the thickness of products from at least three lots be measured. The validation study should be conducted using a product that represents the thickest product measured. If an establishment has a quality specification for thickness, the maximum thickness could also be used to select the thickest product to study. If an establishment packages products by portion size (e.g., 10, 12, or 14 ounces), then it should determine the variability in thickness of products packaged at that portion size and conduct the validation study using a product that represents the thickest product. It should do so because thickness is the factor that affects heat transfer. Again, products from at least three lots should be measured to determine the worst case scenario.

- **Type of cut (e.g., steak or roast):** Related to the thickness of the product, the type of cut can also affect heat transfer because of differences in size, shape, presence or absence of a bone, and fat content. To account for these differences, cooking instructions for each cut should be validated separately.

Testing variables

- **Method of cooking:** Cooking instructions may be provided for multiple cooking methods/devices. Common methods of cooking for mechanically tenderized beef products such as steaks and roasts include cooking by conventional oven, gas grill, or stove top. When testing cooking instructions for conventional ovens, testing should be done on electric, gas, as well as convection ovens if possible to determine whether the instructions work on all types of ovens. Before beginning the validation study, a cold spot determination should be conducted to support that even in the coldest spot the desired endpoint temperature is reached. FSIS does not recommend that cooking instructions be developed for microwave ovens because of the difficulty in applying heat uniformly. For more considerations related to different cooking methods, see the Grocery Manufacturer's Association (GMA) 2008 *Guidelines for Validation of Consumer Cooking Instructions for Not-Ready-to-Eat (NRTE) Products* available at: http://www.gmaonline.org/downloads/wygwam/121894_1.pdf.

- **State of the product at the start of cooking, e.g., frozen versus refrigerated, or room temperature:** The initial temperature of the tested product should be the lowest expected temperature at the start of cooking. As recommended in GMA's 2008 *Guidelines for Validation of Consumer Cooking Instructions for Not-Ready-to-Eat (NRTE) Products*, even if the instructions require thawing before cooking, it may be worthwhile to consider additional tests to assess the impact on cooking adequacy if the consumer does not fully thaw the product before cooking. Alternatively, two sets of validated cooking instructions could be provided: one for preparation of thawed product and one for preparation of frozen product.

- **Multiple units:** The amount of product cooked at the same time needs to be considered, particularly for products cooked in a conventional oven. The cooking instructions may need to be extended if multiple servings are cooked at once. If cooking instructions are written for cooking multiple units (for example two steaks), the instructions should be validated for the same number of units.

- **Type of pan or cooking container:** Establishments may also need to consider the type of pan/cooking container during the design of the validation study. Darker metals tend to heat more quickly than lighter ones. If the type of pan is not included in the cooking instructions, then the establishment should consider using a lighter pan during the validation study to represent a worst-case scenario.

- **Number and location of temperature measurement sites during testing:** Testing of the endpoint temperature should occur in the thickest part of the product. If possible, at least two temperature measurements should be taken per product.

- **Number of replicates:** In order to determine variability in the time it takes to reach the desired endpoint temperature, at least three replicates should be conducted for each type of cooking method studied. Conducting replicates is one of the

KEY POINT: REPLICATES

There is often confusion surrounding the principle of conducting replicates. Often times, multiple products will be tested under the same conditions at the same time (for example, multiple steaks may be placed in the same oven and cooked together); however, these would not be considered true replicates because variability in the oven conditions is not being measured. In order to determine variability in cooking, the steaks would need to be tested separately, under the same conditions, multiple times. For example, one steak would need to be cooked in the oven under the trial conditions. After the results are measured and the oven is cooled, the trial would need to be repeated again with another steak. Each piece of steak tested should be from a different lot so that variability within the product is measured as well.

main principles of the scientific method and involves repeating the entire trial over again under the same conditions multiple times to determine the reproducibility of the results. Guidance is provided later in this document on how to evaluate the results from the different replicates.

- **Rest or dwell time after cooking:** If the scientific support for the minimal internal endpoint temperature indicates a rest time is needed in order to achieve adequate reduction in pathogens, then this fact should be noted in the trial design so that the instructions are developed appropriately. A "rest or dwell time" is the amount of time the product remains at the final temperature, after it has been removed from a grill, oven, or other heat source. During the time after meat is removed from the heat source, its temperature remains constant or continues to rise, which destroys pathogens. If the product is covered during the rest time to help maintain the final temperature, this fact should be noted as well.

- **Rotation of product:** If the product is flipped part way during cooking, this fact should be documented in the testing and included in the instructions.

Testing methodology

After the establishment has identified the product and testing variables, the testing methodology should be determined. If cooking instructions are already available for the product, the establishment can repeatedly prepare the product following the instructions and determine whether the desired endpoint temperature is consistently met.

If instructions are not available, the establishment can collect data during cooking to determine the length of time it takes to reach the desired endpoint temperature. To make this measurement of the internal temperature during cooking, a stainless steel thermocouple can be inserted from one end into the center of the product. To achieve more accurate measurement, another stainless steel thermocouple can be inserted in the center of the product from the opposite end. The temperature can be continuously monitored with thermocouple data logger at 5 second intervals. The product can then be cooked using the desired cooking method until the desired endpoint temperature is reached, at which point the amount of time it took to reach the temperature can be recorded. If two thermocouples are used, the time recorded should be the time it takes for both thermocouples to reach the desired endpoint temperature. See Luchansky et al., 2011 and 2012 for an example of this testing methodology.

In either case, the product should be prepared under the same conditions at least three separate times (i.e., three replicates should be conducted) to support the results are repeatable by consumers. Establishments may determine to conduct additional replicates after consulting with a statistician.

An example of a trial that could be used to validate cooking instructions that takes these product and testing variables into account is provided in Attachment 3.

How to evaluate the results

If labeling instructions were developed before the study is conducted, and the goal of the study was to validate whether these instructions achieved the desired endpoint temperature, when evaluating the data, if all of the temperatures taken following the instructions met or exceeded the target temperature, then the cooking instructions can be considered adequate. When not all data are at or above the target temperature a statistical analysis of the data points is recommended. As recommended in GMA's 2008 *Guidelines for Validation of Consumer Cooking Instructions for Not-Ready-to-Eat (NRTE) Products*, one approach is to calculate the z-value for the data. The Z-value formula is:

Z = (average temperature – target temperature)/standard deviation

The average temperature is calculated from all data for products cooked using the instructions being tested. The target temperature is the temperature that the instructions are designed to achieve. The standard deviation is a calculation representing the variability or spread in the data for products cooked using the instructions being tested.

The calculated Z-value is used to determine the probability that a random temperature value would be less than the target temperature by comparing it with Z-values from a statistical table (see Attachment 4). For example, using the Table in Attachment 4, a Z-value equal to or greater than 2.33 means that 99% of the time, when the product is cooked using the instructions, the temperature will be at or above the target temperature. One percent of the time (or about 1 in 100 times) the temperature will be below the target. From a public health perspective, establishments should try to achieve a Z-value greater than 2.33 to have a high degree of confidence, that when followed, the cooking instructions will result in a temperature at or above the target temperature.

If instructions were not available prior to the study, and the study was used to determine the time it takes to reach the endpoint temperature, then the establishment should use the worst-case scenario result from all of the replicates as the cooking instructions. Thus, if there was variability in the length of time it took to reach the endpoint temperature, the cooking instructions should be developed using the longest amount of time needed to achieve the desired endpoint temperature.

In some cases, the establishment may need to conduct statistical analyses to determine whether significant differences were found between testing scenarios. For example, if an establishment wants to provide a single set of instructions for both electric and gas ovens, the instructions should be validated using both types of cooking. The establishment should then conduct statistical analyses to determine whether there were any significant differences in the time it took to reach the desired endpoint temperature using the two methodologies. If no significant differences are found, then the establishment can conclude that a single set of instructions would be sufficient.

If cooking instructions are changed for product quality reasons or if the product or testing variables are changed (e.g., the thickness of the steak increases), the new instructions should be validated to support product safety. In addition, establishments should closely monitor calls to their toll free numbers and other consumer complaints for signs that the cooking instructions are not easily followed or, when followed, do not adequately cook the product.

ELEMENT 2: In-plant Validation Data (Execution)

Once an establishment has identified scientific support for the cooking instructions chosen, it then needs to implement the same critical operational parameters from the scientific support that were used to develop the cooking instructions. The critical operational parameters related to the product that should be implemented in the actual process include the:

- Cut of beef,
- Method of tenderization, and
- Thickness.

In order to meet the second element of validation, the establishment needs to demonstrate that the product the instructions are used for meet these critical operating parameters. To gather data demonstrating that they do, the establishment needs to collect in-plant data supporting that the cut of beef, method of tenderization, and thickness of product that bear the cooking instructions match those of the product for which the cooking instructions were developed.

After collecting the in-plant validation data, the establishment should verify on an on-going basis that the critical operational parameters continue to be met and match those used in the scientific support. It is up to the establishment to support the frequency with which the critical operational parameters are verified. These data may already be collected by establishments on an ongoing basis as part of quality specifications.

References

Berry, B.W. 2000. Use of infrared thermography to assess temperature variability in beef patties cooked from the frozen and thawed states. Foodservice Research International. 12(4): 255-262.

Bigner-George, M.E. and Berry, B.W. 2000. Thawing prior to cooking affects sensory, shear force, and cooking properties of beef patties. Journal of Food Science. 65(1): 2-8.

Culpepper, W., Ihry, T., Medus, C., Ingram, A., Von Stein, D., Stroika, S., Hyytia-Trees, E., Seys, S., Sotir, M.J.. Multi-state outbreak of *Escherichia coli* O157:H7 infections

associated with consumption of mechanically-tenderized steaks in restaurants – United States, 2009. Presented at International Association for Food Protection; August 1-4, 2010; Anaheim, CA.

Gill, C.O., Yang, X., Uttaro, B., Badoni, M. and Liu, T.. 2013. Effects on survival of *Escherichia coli* O157:H7 in non-intact steaks of the frequency of turning over steaks during grilling. Journal of Food Research. 2(5): 77-89.

Grocery Manufacturer's Association (GMA). 2008. Guidelines for Validation of Consumer Cooking Instructions for Not-Ready-to-Eat (NRTE) Products. Available at: http://www.gmaonline.org/downloads/wygwam/121894_1.pdf.

Goodfellow, S. J. and W. L. Brown. 1978. Fate of *Salmonella* Inoculated into Beef for Cooking. Journal of Food Protection. 41: 598-605.

Health Canada. 2014. Guidance on Mandatory Labelling for Mechanically Tenderized Beef. Food Directorate, Health Products and Food Branch. Available at: http://www.hc-sc.gc.ca/fn-an/alt_formats/pdf/legislation/guide-ld/mech-tenderized-beef-boeuf-attendris-meca-eng.pdf.

Line, J.E. Fain, A.R. Moran, A.B, Martin, L.M., Lechowch, R.V., Carosella, J.M., and Brown, W.L. 1991 Lethality of heat to Escherichia coli O157:H7: D-value and Z-value determinations in ground beef. Journal of Food Protection. 54: 762-766.

Luchansky, J.B., Porto-Fett, A.C.S., Shoyer, B.A., Call, J.E., Schlosser, W., Shaw, W., Bauer, N., Latimer, H. 2011. Inactivation of shiga toxin-producing O157:H7 and non-O157:H7 shiga toxin-producing *Escherichia coli* in brine-injected gas-grilled steaks. Journal of Food Protection. 74: 1054-1064.

Luchansky, J.B., Porto-Fett, A.C.S., Shoyer, B.A., Call, J.E., Schlosser, W., Shaw, W., Bauer, N., Latimer, H. 2012. Fate of shiga toxin-producing O157:H7 and non-O157:H7 *Escherichia coli* cells within blade-tenderized beef steaks after cooking on a commercial open-flame gas grill. Journal of Food Protection. 75: 62-70.

Luchansky, J.B., Porto-Fett, A.C.S., Shoyer, B.A., Phillips, J., Chen, V., Eblen, D.R., Cook, V., Mohr, T.B., Esteban, E. and Bauer, N. 2013. Fate of shiga toxin-producing O157:H7 and non-O157:H7 *Escherichia coli* cells within refrigerated, frozen, or frozen then thawed ground beef patties cooked on a commercial open-flame gas or a clamshell electric grill. Journal of Food Protection. 76(9): 1500-1512.

National Advisory Committee on Microbiological Criteria for Foods (NACMCF). 2006. Response to the Questions Posed by the Food Safety Inspection Service Regarding Consumer Guidelines for the Safe Cooking of Poultry Products. U.S. Department of Agriculture, Food Safety and Inspection Service, Washington, DC. Available at: http://www.fsis.usda.gov/wps/portal/fsis/topics/data-collection-and-reports/nacmcf/current-subcommittees/consumer-guidelines-for-the-safe-cooking-of-

poultry-products .

National Advisory Committee on Microbiological Criteria for Foods (NACMCF). 1997. Recommendations for Appropriate Cooking Temperatures for Intact Beef Steaks & Cooked Beef Patties for the Control of Vegetative Enteric Pathogens. U.S. Department of Agriculture, Food Safety and Inspection Service, Washington, DC.

Savell, J.W., Lorenzen, C.L., Neely, T.R., Miller, R.K., Tatum, J.D., Wise, J.W., Taylor, J.F., Buyck, M.J., Reagan, J.O. 1999. Beef customer satisfaction: cooking method and degree of doneness effects on the top sirloin steak. Journal of Animal Science. 77: 645-652.

Swanson, L. E., J. M. Scheftel, D. J. Boxrud, K. J. Vought, R. N. Danila, K. M. Elfering, and K. E. Smith. 2005. Outbreak of *Escherichia coli* O157:H7 infections associated with nonintact blade-tenderized frozen steaks sold by door-to-door vendors. Journal of Food Protection. 68: 1198–1202.

Attachment 1: Summary of Published Scientific Support for Cooking Instructions

Cut of Meat	Method of Tenderization	Thickness	Cooking Method	Endpoint Temperature	Validated Cooking Instructions	Reference
Top butt steak	Brine injection	1 in	Open-flame gas grill (380°F)	160°F	*For a 1 inch steak:* Cook on a gas grill for 10 minutes, flip and cook for another 10 minutes until the steak reaches an internal temperature of 160°F as measured with a food thermometer.	Luchansky, J.B., Porto-Fett, A.C.S., Shoyer, B.A., Call, J.E., Schlosser, W., Shaw, W., Bauer, N., Latimer, H. 2011. Journal of Food Protection. 74(7): 1054-1064.

*Initial research did not include a rest or dwell time, however, in order to achieve a 5-$\log_{10}$ reduction of *Salmonella* and *E. coli* O157:H7 a rest time should be included (see Attachment 2 of this guidance document for support).

Cut of Meat	Method of Tenderization	Thickness	Cooking Method	Endpoint Temperature	Validated Cooking Instructions	Reference
Top butt steak	Needle tenderized	1 in 1.5	Open-flame gas grill (380°F)	150°F 160°F	*For a 1 inch steak:* Cook on a gas grill for 3 ½ minutes, flip and cook for another 3 ½ minutes until the steak reaches an internal temperature of 150°F as measured with a food thermometer. Allow the steak to rest for 1 minute*****. *For a 1½ inch steak:* Cook on a gas grill for 8.5 minutes, flip and cook for another 8.5 minutes until the steak reaches an internal temperature of 150°F as measured by a food thermometer. Allow the steak to rest for 1 minute*****. *For a 1 inch steak:* Cook on a gas grill for 5 minutes, flip and cook for another 5 minutes until the steak reaches an internal temperature of 160°F as measured by a food thermometer. *For a 1½ inch steak:* Cook on a gas grill for 8 minutes, flip and cook for another 8 minutes until the steak reaches an internal temperature of 160°F as measured by a food thermometer.	Luchansky, J.B., Porto-Fett, A.C.S., Shoyer, B.A., Call, J.E., Schlosser, W., Shaw, W., Bauer, N., Latimer, H. 2012. Journal of Food Protection. 75(1): 62-70.

*Initial research did not include a rest or dwell time, however, in order to achieve a 5-$\log_{10}$ reduction of *Salmonella* and *E. coli* O157:H7 a rest time should be included (see Attachment 2 of this guidance document for support).

Cut of Meat	Method of Tenderization	Thickness	Cooking Method	Endpoint Temperature	Validated Cooking Instructions	Reference
Eye of round steak	Blade tenderized*	0.4 in (1.0 cm) 0.6 in (1.5 cm) 0.8 in (2.0 cm)	Hot plate heated to 392°F (200°C)	145°F	*For a 0.4 in inch steak:* Heat stainless steel skillet on electric stove to medium. Add steak to skillet and cook for 5 minutes. Turn product over at least twice during cooking. Cook until steak reaches an internal temperature of 145°F as measured by a food thermometer and allow to rest for 3 minutes**. *For a 0.6 in inch steak:* Heat stainless steel skillet on electric stove to medium. Add steak to skillet and cook for 11 minutes. Turn product over at least twice during cooking. Cook until steak reaches an internal temperature of 145°F as measured by a food thermometer and allow to rest for 3 minutes**. *For a 0.8 in inch steak:* Heat stainless steel skillet on electric stove to medium. Add steak to skillet and cook for 14 minutes. Turn product over at least twice during cooking. Cook until steak reaches an internal temperature of 145°F as measured by a food thermometer and allow to rest for 3 minutes**.	Gill, C.O., Yang, X., Uttaro, B., Badoni, M. and Liu, T.. 2013. Effects on survival of *Escherichia coli* O157:H7 in non-intact steaks of the frequency of turning over steaks during grilling. Journal of Food Research. 2(5): 77-89.

*Method of inoculation used in is an approximation to contamination by bacteria from tenderizer blades.
**Initial research did not include a rest or dwell time, however, in order to achieve a 5-$\log_{10}$ reduction of *Salmonella* and *E. coli* O157:H7 a rest time should be included (see Attachment 2 of this guidance document for support).

Cut of Meat	Method of Tenderization	Thickness	Cooking Method	Endpoint Temperature	Validated Cooking Instructions	Reference
Eye of round steak	Blade tenderized*	1.0 in (2.5 cm) 1.2 in (3.0 cm)	Hot plate heated to 392°F (200°C)	145°F	*For a 1.0 in inch steak:* Heat stainless steel skillet on electric stove to medium. Add steak to skillet and cook for 26 minutes. Turn product over at least twice during cooking. Cook until steak reaches an internal temperature of 145°F as measured by a food thermometer and allow to rest for 3 minutes***. *For a 1.2 in inch steak:* Heat stainless steel skillet on electric stove to medium. Add steak to skillet and cook for 25 minutes. Turn product over at least twice during cooking. Cook until steak reaches an internal temperature of 145°F as measured by a food thermometer and allow to rest for 3 minutes***.	Gill, C.O., Yang, X., Uttaro, B., Badoni, M. and Liu, T.. 2013. Effects on survival of *Escherichia coli* O157:H7 in non-intact steaks of the frequency of turning over steaks during grilling. Journal of Food Research. 2(5): 77-89.

Cut of Meat	Method of Tenderization	Thickness	Cooking Method	Endpoint Temperature	Validated Cooking Instructions	Reference
Eye of round steak	Blade tenderized*	0.8 in (2.0 cm) 1.2 (3.0 cm)	Hot plate heated to 338°F (170°C)	145°F	*For a 0.8 inch steak:* Heat stainless steel skillet on an electric stove to medium-high. Add steak to skillet and cook for 17 minutes. Turn product over at least twice during cooking. Cook until steak reaches 145°F and allow to rest for 3 minutes****.** *For a 1.2 inch steak:* Heat stainless steel skillet on an electric stove to medium-high. Add steak to skillet and cook for 33 minutes. Turn product over at least twice during cooking. Cook until steak reaches 145°F and allow to rest for 3 minutes****.**	Gill, C.O., Yang, X., Uttaro, B., Badoni, M. and Liu, T.. 2013. Effects on survival of *Escherichia coli* O157:H7 in non-intact steaks of the frequency of turning over steaks during grilling. Journal of Food Research. 2(5): 77-89.
Eye of round steak	Blade tenderized*	0.8 in (2.0 cm) 1.2 (3.0 cm)	Hot plate heated to 446°F (230°C)		*For a 0.8 inch steak:* Heat stainless steel skillet on an electric stove to high. Add steak to skillet and cook for 14 minutes. Turn product over at least twice during cooking. Cook until steak reaches 145°F and allow to rest for 3 minutes****.** *For a 1.2 inch steak:* Heat stainless steel skillet on an electric stove to high. Add steak to skillet and cook for 29 minutes. Turn product over at least twice during cooking. Cook until steak reaches 145°F and allow to rest for 3 minutes****.**	

*Method of inoculation used in is an approximation to contamination by bacteria from tenderizer blades.
**Initial research did not include a rest or dwell time, however, in order to achieve a 5-$\log_{10}$ reduction of *Salmonella* and *E. coli* O157:H7 a rest time should be included (see Attachment 2 of this guidance document for support).

Attachment 2: FSIS Guidance on Safe Cooking of Non-Intact Meat Chops, Roasts, and Steaks April 2009

Temp °F	Temp °C	Time for 5.0-log_{10}Reduction	Unit Time
130	54.4	86	min.
131	55.0	69	min.
132	55.6	55	min.
133	56.1	44	min.
134	56.7	35	min.
135	57.2	28	min.
136	57.8	22	min.
137	58.4	18	min.
138	58.9	14	min.
139	59.5	11	min.
140	60.0	9	min.
141	60.6	7	min.
142	61.1	6	min.
143	61.7	5	min.
144	62.2	4	min.
145	62.8	3	min.
146	63.3	130	sec.
147	63.9	103	sec.
148	64.4	82	sec.
149	65.0	65	sec.
150	65.6	52	sec.
151	66.1	41	sec.
152	66.7	33	sec.
153	67.2	26	sec.
154	67.8	21	sec.
155	68.3	17	sec.
156	68.9	14	sec.
157	69.4	11	sec.
158	70.0	0	sec.
159	70.6	0	sec.
160	71.1	0	sec.

The required lethalities are achieved instantly when the internal temperature of a cooked meat product reaches 158°F or above.

This Time/Temperature table is based on Thermal Death Curve for *Salmonella* in Beef Emulsions in tubes derived from Goodfellow & Brown, 1978[1,2].

[1] Goodfellow, S. J. and W. L. Brown. 1978. Fate of *Salmonella* Inoculated into Beef for Cooking. Journal of Food Protection. 41: 598-605.

[2] All times that were a fraction of a minute or second was rounded up to the next whole number (e.g., 16.2 seconds for 155 °F was round up to 17 seconds.

Attachment 3: Example Validation of Conventional Oven Cooking Instructions for a Needle Tenderized Roast

Validation Trial Product Summary Sheet	
Date: 12/5/2012	
Product Name: Roast #456	
Product variables	
Method of tenderization	Needle Tenderized
Thickness of the product	5 inches
Type of cut	Eye-round roast (3 lbs)
Testing variables	
Method of cooking	Both ovens were preheated to 350°F Electric oven – KitchenAid Model #: 5678 Serial #: LMN5678 Gas oven – LG Model #: 12345 Serial #: ABC12345
State of the product at the start of cooking, e.g., frozen versus refrigerated, or room temperature	Refrigerated
Multiple units	Only one roast was tested at a time because this is how the consumer would ordinarily prepare the product
Type of pan/cooking container	The roast was cooked in a light pan (uncovered) to represent worst case scenario
Number and location of temperature measurement sites during testing	Two temperature measurements were taken in the center of the roast (the thermocouples were inserted into opposite ends of the roast)
Number of replicates	The testing methodology was repeated three times for each method of cooking (electric and gas)
Endpoint temperature	150°F
Rest time after cooking	1 minute
Rotation of product	None

Test methodology:

First, a cold spot determination was conducted for each type of oven in which oven temperatures were taken in five different locations (front left, front right, back left, back right, and center) on each rack in the oven.

After the cold spot determination was complete, the oven was heated to 350°F. Then product (at refrigeration temperature) was placed in the oven on a light colored pan in the location previously identified to be the coldest. Two calibrated, stainless steel thermocouples were inserted from opposite ends of the product into the center of the roast to measure the internal temperature of the roast during cooking. The temperature of the roast was continuously monitored with an eight-channel thermocouple data logger at 5 second intervals. The roast was removed from the oven when both thermocouples within the roast reached 150°F. Time was recorded at this point. The temperature of the roast was measured after the 1 minute rest time to ensure that the product temperature remained at 150°F while it was uncovered.[3]

This entire procedure, beginning after the cold spot determination, was repeated three times. Results were recorded on the charts below.

Results:

Electric oven preheated to 350°F

	Time to reach 150°F
Trial 1	91 minutes
Trial 2	97 minutes
Trial 3	90 minutes

Gas oven preheated to 350°F

	Time to reach 150°F
Trial 1	98 minutes
Trial 2	89 minutes
Trial 3	93 minutes

A two-sample t-test was conducted and it was determined that the difference in the mean time to reach 150°F using the gas and electric oven was not statistically significant.

Conclusions:

A single set of instructions can be created for electric and gas ovens since the difference in time it took to reach the desired endpoint temperature was not statistically significant. Since the longest amount of time it took to reach 150°F was 98 minutes, this value will be rounded up for the instructions so that consumers are instructed to cook

[3] This method was adapted from Luchansky et al. 2011 and 2012.

the product for 1 hour and 40 minutes (or 100 minutes). Consumers will also be instructed to allow the product to rest for 1 minute. An example of the final validated cooking instructions are provided below.

For Food Safety and Quality Follow These Cooking Instructions:
Electric or gas oven:
1) Heat oven to 350°F.
2) Cook for 1 hour and 40 minutes to an internal temperature of 150°F as measured with a food thermometer.
3) Remove from oven and allow meat to rest for 1 minute.

Attachment 4: Z-Table (Cumulative Probabilities of the Standard Normal Distribution Entry)

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.5	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
-0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
+0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997

http://askfsis.custhelp.com/

FSIS/USDA
www.fsis.usda.gov
2015